Electronic Market Trading Platform for Forex Trading Using Reverse Auction

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1 Abstract

Purchasing Forex online has become popular among people who wish to make money and to purchase Forex at a lower cost. The online Forex trading platform uses the reverse auction method as a form of exchanging Forex between buyers and sellers. The reverse auction method includes having the buyer request for the currency and the seller bidding in response to the request. In this paper we initially analyze the difference between the forward and reverse auction method before discussing the Forex trading platform in detail. We have included the advantages and disadvantages of the Forex trading platform using reverse auction.

A detailed explanation of the user interface specification is provided, along with use case diagrams to provide a better understanding of the interface. The implementation process require using tools that will allow us to create a forest trading prototype that uses the reverse auction and knapsack algorithm. Functionality testing, unit testing, integration testing and usability testing are done on the platform to ensure that no known errors occur and all requirements are met.
2 Introduction

Foreign Exchange (Forex) trading is the process of trading one currency to another. During the ancient times currency was exchanged, so that people could buy and sell items like food. Alex.Brown and Sons traded foreign currencies exchange sometime about 1850 and was a leading participant in this within U.S.A [9]. The shift from ancient to modern time caused Forex trading to be done the traditional way where Forex was purchased over the counter and at times people had to travel long distances just to purchase Forex. Until the early 1990s, all foreign exchange trading was conducted via telephone[8] to reduce wasted time. As time progressed better trading methods were invented. The development in technology online Forex trading was introduced which is a platform that enables the process of changing currency to be done online. Online Forex trading occurs over a period of twenty four hours a day, each and everyday. Despite the fact that trading occurs at any time of the day certain places have specific active trading times, for instance in London the most active hours for Forex trading are between the opening market hours at eight in the morning and the end of the United States market hours at ten in the evening. During the market hours the busiest time for Forex trading is at one in the afternoon until four in the afternoon.

We focus on the Electronic market trading platform for Forex trading using reverse auction on electronic devices. The Electronic Market Trading Platform for Forex trading using reverse auction focuses on the process of changing one currency to another and provides information about the trade market on electronic devices. The online Forex trading platform does not have a centralized location as users can access the trading platform on their mobile phones, computers and other electronic devices as long as they have internet access. In this project we will focus on Forex trading using reverse auction via electronic devices. The users of the online Forex trading platform will be classified into two groups, namely the buyer and seller where the buyer is the one that requests for a specific currency and the seller then responds by sending a detailed offer which includes the value of the product and the commission charged.

Online trading auctions are developed using the forward and reverse auction method, where the forward auction method is not implemented in the online Forex trading market due to the fact that it focuses only on keeping the seller happy by giving the seller the option of selecting the highest bid for the product they are selling. The main focus of the Forex trading platform is to ensure that buyers keep requesting for Forex. Therefore the Forex trading platform will use reverse auction which is created to benefit both the buyer and the seller, even though the seller can sometimes run at a loss when selling their currency for an amount that is lower than what the Forex should be sold for, the main goal for the objective is that the buyer is to buy units of one product with as low cost as possible[7] offer from the sellers and to allow the buyer to be in control of the whole trading process. The trading process is then implemented using the reverse auction method which consists of both the open and sealed auction process. The open auction process enables group bidding and the sealed auction process is a more private bidding method where only the buyer can see the offers.
The user requirements for the Forex trading platform specify what the user expects to see in the platform and the functional requirements specifies what we expect the platform should do are the two important factors that determine how the Forex trading platform should be developed and what should the platform contain. A short description of how the South African Reserve Bank (SARB) protects the countries currency to ensure sustainable and economic growth in the Republic, as well as why the interest rate and the rate of inflation changes frequently is included as well as an example of an online Forex trading platform that we have used to determine the purpose of having a Forex trading platform and how the trading charts can be interpreted. Figure 4 is an example of a trading chart with a description of what each line means.

The user interface specifications provide a detailed description about the platform and how users will be able to access the system. The main system tasks include registering, logging in and out, placing a request and bid, as well as removing the requests and bids. The user interface specification provide the two types of users that will interact frequently with the system and what each users role are. The high level design provides use case diagrams that explain each process that a user has to go through during the auction period. While the low level design is simply an explanation of the high level design in pseudo code.

Software implementation is the process of creating a system that meets all the functional requirements. Implementation is done using different programming languages as well as programming functions that cater for these languages. The programming languages that we used are PHP,MySQL,CSS and HTML. These languages have enabled the use of a database to store all details and are able to display the details on the interface.

Using the above mentioned programming languages the platform is implemented to enable users to place a request, bid on the request, register, login, logout, delete requests and bids, and to view rates and linear regression graph. A functionality test is then performed to ensure that the system has no known errors and all functions required have been met. The unit testing process is tests the functionalities individually. Once all functions pass the test an integration test is performed to validate that all functions work simultaneously with few operational issues. The usability test is then performed to get the users view about the platform and provide their own suggestions. Test results simply provide a visual representation of the result obtained in a survey provided to users after the usability testing process.
3 Literature Review

The South African Reserve Bank (SARB) rules which are meant to pro- tect the value of the South African currency in order to ensure a balanced growth in the republic. The SARB act is said to provide the level of inflation which offers price stability and the rate at which stability is achieved. The Repurchase transactions is known as the interest that is market determined in auctions. Inflation gaps provide the possibility of fluctuation and inflation around the steady values which have resulted from self full filling revisions in expectations. The decline in real interest rates is the result of inflation being below unity and the decline in interest rates stimulates aggregate demand which induces a rise in inflation. This is described in article[3].

<table>
<thead>
<tr>
<th>Advantage</th>
<th>Disadvantage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allowed to use reduced Value Added Reseller (VAR) equation, instead of a full VAR to calculate inflation</td>
<td>Given that the dependent variable is the four quarter ahead inflation rate the equation does not always provide a positive forecast.</td>
</tr>
<tr>
<td>Can determine the forecast a quarter ahead.</td>
<td></td>
</tr>
</tbody>
</table>

The next article states that the auction clock counts downwards towards zero and during that time frame there is only one person highest/lowest bidder and when an auction ends the lowest bidder takes the item. Once the auction clock reaches zero it is then set back to its reset time. The article then defines the persistent bidder as someone who uses the Bid-O-Matic and never stops bidding while part of an auction. the persistent bidder uses the Bid-O-Matic frequently but still has times when the bidder is not using the Bid-O-Matic and bids infrequently and only at the last second. There are different types of bidding algorithms, Firstly, the bidding algorithm which is someone who never place a single bid.secondly,constant time bids whenever the clock reaches a set time to bid. thirdly, constant time Bid-O-Matic which allows another bidder to place a bid. fourthly, Ending pattern which is the single bid as the clock approaches zero. The measures of success which are used are the average profit per auction and the average profit per won auction. The description above is given in article[2].

<table>
<thead>
<tr>
<th>Advantage</th>
<th>Disadvantage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enables a group of bidders to bid on a product</td>
<td>Bidders have a short time period to bid.</td>
</tr>
</tbody>
</table>
Foreign exchange trading in article[1] is defined as the process of trading one currency to another through the use of the internet and does not have any specific location from which the trading activities take place. Trading process is faster and easy, displays previous statistics on past trade ins and provides the ability to purchase from the cheapest supplier. Many companies categorize the feedback about the reverse auction as product characteristics which has better candidates if its based on price, market characteristics which has the competition between suppliers determine the success of the reverse auction and buyer-seller relationship where the buyer makes a long term commitment to the supplier and the supplier makes substantial investments to satisfy the buyer requirements.

<table>
<thead>
<tr>
<th>Advantage</th>
<th>Disadvantage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduces purchase cost for buyers.</td>
<td>Time saving and price reduction impacts the buyer-seller cooperation and suppliers strategic relationships.</td>
</tr>
<tr>
<td>Increased efficiency in the market.</td>
<td>Close partnership between buyer and seller is lost.</td>
</tr>
<tr>
<td></td>
<td>Provides newer companies with a chance to compete as long as they meet the buyers qualification standards.</td>
</tr>
</tbody>
</table>

A list of the benefits provided by the internet to the consumer which includes lower prices, more choices and the latest products is provided in article [4]. Internet surveys provide information on whether or not people would purchase products online. The results obtained are then presented using the chi-square and the t-test.

<table>
<thead>
<tr>
<th>Advantage</th>
<th>Disadvantage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consumers are provided with information about the products and stores.</td>
<td>Lack of physical stores for queries.</td>
</tr>
<tr>
<td>Makes searching for products easier.</td>
<td>No store helplines besides emails.</td>
</tr>
</tbody>
</table>

The role of both the buyer and seller is described in article[7]. Where the buyers objective is to purchase a product at a very low cost. The sellers are competitive with one another and send the buyer offers that include discount prices and corresponding conditions. Buyers have the task of paying the chosen offer the amount that was offered.

<table>
<thead>
<tr>
<th>Advantage</th>
<th>Disadvantage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buyer chooses the seller that they want to purchase from.</td>
<td>Seller does not always make a good profit.</td>
</tr>
<tr>
<td>Buyer obtains the product at a lower cost.</td>
<td>Buyer faces the possibility of being scammed.</td>
</tr>
</tbody>
</table>
Customers are defined to be firms or individuals who buy or sell foreign exchange in article[8]. Corporate companies tend to purchase forex when they need to purchase an item from another country. Dealers are responsible to make profit for the banks which supply quotes about the requested forex to the customers. Banks provide electronic trading functions that allow direct bank customer trading compared to the forex trading process which occurred via telephone call back in the 1980s. Users can trade without regard to physical location. Allows any number of trade, size of trade or asset to vary in cost. Automates processing and clearing of trading.
4 Auction Mechanism

4.1 Difference Between Forward and Reverse Auction

The forward auction method is known as the traditional auction method. Forward auction consists of both the seller and buyer, where the seller advertises which item to sell and buyers have to compete for the item by driving the price of the item upwards. The forward auction method is commonly used when dealing with products such as computers, books and vehicles. Buyers who participate in forward auctions are normally advised to always do a little research on the item being advertised before placing a bidding price. This is due to the fact that sellers may omit valuable information about the item in order to have a good description of the item.

The reverse auction method has the buyer requesting for a product and suppliers sending information and prices about the product being requested. The suppliers offer include a discount package and commission charged on the product at all times. The buyer then has a task of selecting which supplier to purchase from and in the end the supplier with the lowest purchase price is always selected as the buyer is in control of the bidding process. Online trading markets that are using the reverse auction method always run a background check on the suppliers before allowing them to bid unlike the forward auction method which allows anyone to sell their product online.

Figure 1: This figure is a representation of the forward auction method which was taken from the article [5]. The seller advertises which item to sell and buyers have to compete for the item by driving the price of the item upwards.

Figure 2: This figure is a representation of the reverse auction method which was taken.
from the article [5]. The reverse auction method has the buyer requesting for a product and suppliers sending information and prices about the product being requested.

4.2 Forex Trading Platform

The Forex trading platform will be implemented using the reverse auction method, which is normally used for Forex, personal finance, real estate and insurance policy. Open and sealed bidding occur during the Forex auction process, where open bidding allows a group of bidders to bid at the same time and sealed bidding only lets the buyer see the bids. The Forex trading platform using reverse auction objective of a buyer is to purchase the Forex at a lower cost from sellers. The prices sent by the sellers include discount prices, commission and corresponding conditions. Purchased Forex is delivered to the buyer once payments have been made and a mutual agreement between the buyer and seller has been made.

<table>
<thead>
<tr>
<th>Advantage</th>
<th>Disadvantage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduced purchase cost for buyers.</td>
<td>Buyers stand a higher chance of being scammed.</td>
</tr>
<tr>
<td>Allows group bidding.</td>
<td>Price reduction have a negative impact on sellers.</td>
</tr>
<tr>
<td>Provides information about the trading market.</td>
<td>Sellers are provided with a short time period to bid.</td>
</tr>
<tr>
<td>Saves time</td>
<td>No relationship between the buyer and seller due to price focus.</td>
</tr>
<tr>
<td>Faster than the traditional trading method.</td>
<td>Few stores and helplines available.</td>
</tr>
<tr>
<td>Provides buyer with the opportunity</td>
<td></td>
</tr>
<tr>
<td>to compare prices</td>
<td></td>
</tr>
</tbody>
</table>

Table 1: Shows the advantages and disadvantages of the Forex trading platform using reverse auction, which were taken from [1, 4].

4.3 Types of Auction and Bids

The reverse auction method used during Forex trading is an auction that has a buyer requesting for Forex and sellers bidding in response to the request. There are four types of auctions that use the reverse auction method which have been developed for the trading platform. Firstly, the English auction for reverse auction has the supplier placing a bid that is better than the lead, which in this case would be offering the Forex at a lower cost than the lead bidder. Once the sellers have stopped competing for the sale, the bidding process then stops and the lowest bidder is chosen. Secondly, the Dutch auction organizes the sellers according to the currency they sell, the buyer is the person that accepts the offer made by the sellers. Thirdly, the Japanese auction does not have a specific time set for the auction. The auction is carried out until all the other sellers have stopped bidding leaving only one bidder remaining. Fourthly, the Yankee action allows multiple Forex to be auctioned. Once the auction has ended the buyer needs to pay the amount offered by the winning bidder.
The Forex auction platform that uses reverse auction can be created using an open or sealed bidding process, where open bidding implies that the bid takes three to eight hours and suppliers can post bids during that time period. Competitions are higher in an open bid since bidders are encouraged to out bid other suppliers. Sealed bidding discourages competition between bidders as only the Buyer can see the bids and only the selected supplier is informed when their offer is accepted. At times the buyer might end up purchasing the Forex at a higher cost compared to when the auction is an open bid.

5 User Requirements

Below are the requirements that will be implemented in the Electronic Forex trading platform.

5.1 User guide

Tutorials will be in a form of a written document and video, that will provide the user with details about the Forex trading platform, explain what the exchange rates mean and how the trading process occurs. The written document will contain simple easy steps that guide first time users and the videos will provide the same information as the written document, but will be meant for those who don’t want to read.

5.2 Visual Representation

The visual representation includes a linear regression graph, and current exchange rates, delayed by 20 seconds.

5.2.1 Graph

The Graph will be a linear regression graph that provides a visual representation of the forex requested by users. Tags and labels will be used to explain what the graph is about, in order to provide a better understanding of the graph.

5.2.2 Exchange Rates

Exchange rates will be updated constantly according to the market rates to provide users with the most current rates in order to calculate the total cost that a buyer needs to pay.

5.3 Auction time

Auctions will occur over a specific time period after the buyer has requested for the Forex. Sellers will be given a short time period to bid on the forex requested. Once the bidding time has ended an email will be sent to the buyer containing the auction details.
6 Functional Requirements

The system will allow the users to enter their details when registering, logging in and logging out. Once the registration process is done the system needs to send a verification email to the users email address to verify whether the email address entered does exist. User should place a request for the currency they wish to purchase. Users should be able to delete the requests or bids they have placed. Once the bidding period has ended and email should be sent to the buyer with the updated information about their request.

7 Forex Trading Process

At the beginning of each online Forex auction the auction clock indicates the amount of time before the auction ends[2]. The auction clock then counts downwards during the Forex auction giving sellers a chance to bid on the request placed by the buyer. Once the seller hits the bid button to submit their bid, using a combinatorial algorithm the bids are then compared the other bids and if it is lower than the rest of the bids, the bid is placed as the winning bid until a lower offer is made or the bidding time ends. After the bidding time has ended the buyer has to pay the price for the Forex. At the end of the bid when the auction clock is below the reset time, the clock is set back to the reset time.

Figure 3: This is a representation of the trading cycle that occurs during Forex trading [5].

8 Policy Pules and Operating Procedures for the South African Currency

The purpose of the South African Reserve Bank(SARB) is to protect the countries currency and to ensure a balanced and sustainable economic growth. South Africa’s constitution guarantees South African Reserve Banks legal independence. The South African constitution states that : The primary object of [SARB] is to protect the value of the currency in the interest of balanced and sustainable economic growth in the Republic. [SARB], in pursuit of its primary object, must perform its functions independently, but there must be regular consultation between the Bank and the Cabinet member responsible for national financial matters[3] Therefore if Cabinets wish to change the constitution
rules, two thirds of the majority of the Cabinets are required to be able to alter the constitution. Any alterations to the constitutions can also be made in a Constitutional Court.

Monetary policies for the South African Reserve Bank provide guidelines on how Cabinets should be assessed and provides acts that show the level of inflation price stability rate. The reserve bank act does not provide a transparent monetary policy. Despite having all the Reserve bank acts and rules, there are no rules set to assess the performance of the Reserve bank.

Liquid asset ratio based system, Cost of cash reserves based system and Monetary accommodation (Repurchase transactions) are the three Operating Procedures that the SARB follows. The Monetary accommodation (Repurchase transactions) uses the Repo interest, which is the interest rate determined by the current market in auctions. Auctions have different interest rates that changes everyday because SARB wants to see a movement in the interest rate. The purpose of SARB is to ensure that the interest rates charged in auctions does no remain the same at all time, the rates have to fluctuate. This then results in to different cost values for each purchase made on different days. The inflation forecast is a single equation reduced from a VAR system which is used to predict the value of inflation four quarters ahead. The reduced equation is better than the single full VAR system of simplicity and turns out of economic interpretability.
9 Existing Online Forex Trading Platform

Metatrade 4 is a platform for e-trading that is used by online Forex traders and provides the user with real time access to most of the major currency exchange rates over a range of sampling intervals[6]. The Metatrade 4 system has a built in editor and compiler with access to articles and help for the users. Metatrade 4 monitors the market, handles all trades and allows users to trade faster. Separate directories are used to store data and the root directory can be accessed using a terminal that has an origin.txt file, where a user can find the path to the installation folder of the terminal. Metatrade4mobile features include automated trading via expert advisors, built in indicators, multiple chart display and one click trading. The Metatrade 4 program analyzes quotes received and controls the trading account of each user.

Figure 4 : GBP exchange rate signal for 1 hour sample data using Japanese Candles (Green=up; Red=down); Center window: $q_j$ (cyan) and moving average of $q_j$ (Green); Bottom window: first (red) and second (cyan) gradients of the moving average for $(N, M, K, T ) = (512, 10, 300, 0.5) [6]$. 
10 User Interface specification

10.1 Introduction

As part of our design process we have decided to rather create a web based interface as in the end it will be made a responsive website which will be used on portable devices and computers. The web based interface will allow the buyers and sellers to login whenever they need to request or bid. If a user is not registered they will be required to do so as no user can trade forex without verifying that their email address exists. The tasks that will be performed on the interface include registering, logging in, placing forex requests, viewing and deleting requests, as well as bidding and deleting requests. This section describes the two types of users that will be using the interface as well as how the users will be interacting with the system.

10.2 Users

The web interface will consist of two types of users, namely the buyer and the seller. The difference between the buyer and the seller is that the buyer places requests for forex and sellers place bids in response to requests.

10.2.1 Buyer

Buyers are responsible for placing requests. The requests placed by the buyers expire after a specific time period. Buyers will also be required to register or login before they could place any requests.

10.2.2 Seller

Sellers are responsible for placing a bid in response to a request that has been placed. Sellers will also be required to register/login before they can respond to any request placed by buyers. Sellers who place the lowest bid a request will be classified as the winners. During the bidding process the winning bid will be displayed in order for other potential bidders to be aware of what their competition is selling the same product at.

10.3 User interface

The web interface will have functions such as register or login, request and respond.

10.3.1 Register or Login

When registering the buyers and sellers will be required to enter their personal details such their name, surname, password, email and contact number. The registering process will allow users to then login and logout as well as place requests and bids. Email and passwords entered by the users will be used to enable them to login and kept as a record when trading.
10.3.2 Forex Request

Buyers who have already registered or logged in will be able to place as many requests as they will like. Forex requests will be displayed on their own page in a table form that will consists of the currency, forex amount, request date, bid timeout and lowest bid.

10.3.3 Forex Response

Sellers will place responses for each request that is being placed. The sellers will also get an opportunity to see if whether or not the bid they will be placing will be the winning bid or not. Sellers will also be required to register/login before they can be able to place a bid.

10.4 Web Interface

The platform which will be web based, the web interface will consist of a home, register/login, tutorial, trade, requests, rates and graph page.

10.4.1 Home Page

The home page will have a description about forex trading, why a user should trade forex and the trading process steps.

10.4.2 Register or Login Page

The register or login page will consist of a form that will require users to enter their information before proceeding. The information entered on the form will then be stored in the database to keep a record of all registered customers, in turn those are the customers that will be allowed to trade.

10.4.3 Help Page

The user guide page will consists of a more detailed step by step guidance of how to trade forex and request for forex. This page will be explaining everything in the simplest form, as this interface needs to cater for users of all ages.

10.4.4 Trade Page

The trade page will have the forms for requesting. The buyers will have to enter the amount of forex they are looking for as well as the currency. The information entered on the trade page will not only be saved on the database, but will also be displayed to other users who wish to trade as well.

10.4.5 Requests Page

The requests page will display a table that consist of the currency, amount, start to end date and time. The page will also have a button that will require the responders to select in order to bid on a request. Sellers will be able to bid on any amount they wish to sell, provided that it is not more than the required amount and that its not their own request.
10.4.6 Rates Pages
The rates page displays the current foreign exchange rates and are updated when the page is refreshed.

10.4.7 Graph
The graph pages displays a linear regression graph which is a visual representation of the requests placed users.

10.5 High Level Design
The web interface focuses on two major processes which include requesting and responding. These processes are required in order to carry out the forex trading process. In this section we will be looking at the High level design in more detail.

10.5.1 Requesting Process
1. The buyer is required to register and verify their email address.
2. The buyer then has to start off by logging in.
3. The next step will be to place a request which will include the currency and amount of the forex required.
4. The request is displayed on a separate page in a table that consist of the currency, amount, start to end date and time.
5. The buyer will then be provided with the winning offer for the forex required (This information will be sent to the buyers email).
6. Finally the buyers request and winning bid is stored in the database.

Figure 5: This figure is a representation of a use case diagram for the requesting process.
10.5.2 Responding Process

1. The seller is required to register and verify their email.
2. The seller then has to start off by logging in.
3. The next step will be to respond to the requests placed by bidding on the request.
4. The winning bidder information is stored in the database.

![Figure 6: This figure is a representation of a use case diagram for the responding process.](image)

10.5.3 System Overview

The interface will have the sellers and buyers interacting with the system to trade forex. The figure below shows how the seller and the buyer interact with the system and how both users can be requesters or responders. The users will start off by first logging in before deciding on whether or not they want to request for forex or respond to a request. After the trading process is done the users then logout. During the trading and login process the information in the database is updated to keep track of the changes made.

![Figure 7: This figure is a representation of a use case diagram for the Buying and selling process.](image)
10.5.4 System Administrator

The system administrator will be responsible for maintaining the system, which involve activities such as organizing the database, removing the expired requests and updating the interface of the system. The administrator will be required to login to the system before they can access all the private functions.

Figure 8: This figure is a representation of a use case diagram for the Administration process.
11 Low Level Design

The low level design is the explanation of the high level design in pseudo code.

11.1 Requesting Process

The pseudo-code for the requesting process which involves buyers selecting the currency and amount they wish to purchase is as follow:

```plaintext
if (User is a first time user):
    Read in login information
    Read in user details
else:
    Read in login details
    if (Login details is correct):
        Enter currency
        Enter amount
        Start bid timer
        Display requests
        if (Offer is placed and it is the winning offer):
            Display offer
            End bid timer
        else:
            Request for correct login details
```

11.2 Responding Process

The pseudo-code for the responding process which involves the sellers responding on requests while the timeout for each request hasn’t been reached yet is as follow:

```plaintext
if (User is a first time user):
    Read in login information
    Read in user details
else:
    Read in login details
    if (Login details is correct):
        Enter offer
        Repeat:
        if (Offer is placed and it is the winning offer):
            Display offer
            Until bid timer end
        else:
            Request for correct login details
```

11.3 Administrator

The administrator has access to database information, such as organizing the database and changing the interface.
12 Implementation

The implementation process involves having to use various development tools in order to produce a system that contains all the functions listed in the functional requirements. The tools are those that were necessary to endure that the system enable users to register, verify email, login or out, place a request, bid on a request and delete requests or bids. Bellow the development tools are explained as well as the software implementation.

12.1 Tools Used

12.1.1 NetBeans IDE

NetBeans IDE is a tool used for application development in various programming languages. The IDE has a Debugger and Profiler, and tools for versioning control and developer collaboration. The NetBeans IDE provides access to resources such as servers, web servers, databases and error trackers. The resources can be managed on the IDE by adding, removing and modifying data in the databases. Plugins such as HTML5 and PHP are available for development.

12.1.2 PHP

PHP is an open source scripting language that is embedded in HTML. PHP is known as server-sided language because PHP doesn’t get executed on your computer, but on the computer you requested the page from [11]. With PHP login and signup pages are created by taking in details from a form and sending the details to the corresponding tables in a selected database.

12.1.3 MySQL

MySQL is a very powerful program in its own right. It handles a large subset of the functionality of the most expensive and powerful database packages [12]. MySQL works with PHP to alter the database tables by adding and deleting data from in the Tables.

12.1.4 HTML and CSS

HTML uses elements to describe the structure of pages [13]. HTML pages text documents, that use tags that are often referred to as elements. Tags usually come in pairs, which are the opening and closing tags. CSS treats each HTML element as if it appears inside its own box and uses rules to indicate how that element should look [13]. The rules on CSS are made up of selectors and declarations, where they are created on a different documents but still appear within HTML.
12.2 Software Implementation

12.2.1 Registration

The following is a representation of the program used to collect the details entered on the registration form. The details entered are then sent to the database and added to the person table. Once a user selects the sign up button an email is sent to their account to verify if the email entered is valid.

```php
// The following program takes in the data entered by the user on the registration page and sends a verification email to the users email address.
// Once the email address has been sent
if (!isset($_SESSION['login_user']))
    exit;

if (!empty($_POST['name']))
    if (!empty($_POST['surname']))
        if (!filter_var($_POST['email'], FILTER_VALIDATE_EMAIL))
            if (!empty($_POST['contact']))
                if (!empty($_POST['password']))
                    if (!empty($_POST['password_confirmation']))
                        $name = $_POST['name'];
                        $surname = $_POST['surname'];
                        $email = $_POST['email'];
                        $contact = $_POST['contact'];
                        $password = $_POST['password'];
                        $password_confirmation = $_POST['password_confirmation'];
                        $connect = mysql_connect('localhost', 'root', '');
                        $sql = mysql_select_db('project', $connect);
                        $sql = "SELECT * FROM person WHERE email = ". $email;
                        $result = mysql_query($sql);
                        if ($result)
                            $sql = "UPDATE person SET name = ", $name, " surname = ", $surname, " email = ", $email, " contact = ", $contact, " password = ", $password, " password_confirmation = ", $password_confirmation, " status = 'verified' " WHERE email = ", $email;"
                        else
                            echo 'Unable to send email. Please try again.';
                            header('Location: index.php');
                            exit;
                        $sql = mysql_query($sql);
                        if ($sql)
                            echo 'Your email has been sent successfully.';
                            header('Location: index.php');
                        else
                            echo 'Unable to send email. Please try again.';
                            header('Location: index.php');
                        exit;
```

Figure 9: This is the representation of the program that send an email to the user, once they are done registering.
12.2.2 Login or Logout

The following program queries the database in order to establish if the user trying to login already has registered. Once the details entered by the user correspond to those in the database a user session is started and the user is redirected to the home page. When the user logs out the session is ended.

```php
<?php
// Start session by checking if username and password match those in the database.
session_start(); // Starting Session

if (!isset($_POST['submit'])) {
    Error = "Variable To Store Error Message"
    if (empty($_POST['username']) || empty($_POST['password'])) {
        Error = "Email or Password is invalid";
    } else {
        // Define Username and Password
        $email = $_POST['email'];
        $password = $_POST['password'];
        // Establishing Connection with Server by passing serverName, email and password as a parameter
        $connection = mysql_connect("localhost", "root", ";");
        $email = stripslashes($email);
        $password = stripslashes($password);
        $email = mysql_real_escape_string($email);
        $password = mysql_real_escape_string($password);
        // Selecting Database
        $sql = mysql_select_db("Project", $connection);
        // SQL query to fetch information of registered users and finds user match.
        $query = mysql_query("select * from Person where $password AND email=\$email\" ");
        $rows = mysql_num_rows($query);
        if ($rows > 0) {
            while ($row = mysql_fetch_assoc($query)) {
                if ($email == $row['email'] && $password == $row['password']) {
                    $fName = $row['firstName'];
                    $lName = $row['lastName'];
                    $SESSION[\$login_user]=\$email; // Initializing Session
                    header("location: profile.php"); // Redirecting To Other Page
                    if ($SESSION[\$login_user]==\$email) null ( ($password == $row['password'])) {
                        echo "<h2>Email or Password is incorrect</h2>";
                    } else {
                        Error = "Email or Password is invalid";
                    }
                    mysql_close($connection); // Closing Connection
                }
            }
        }
    }
}
```
12.2.3 Place Request

Users who have already registered or logged in are the only ones that are permitted to place a request. Users have the option of ten currencies to select from. Users can only request for a minimum of five hundred for each currency.

![PHP code snippet]

Figure 12: The above representation is the program used to enable users to request for...
forex by selecting the currency and entering the amount.

12.2.4 Bid On Request

The following program takes in the bid and forex amount offered by the bidder then uses knapsack algorithm to find the best combination, that is equal to the requested amount at a low value. All bids are inserted in the database, with the lowest bid displayed in the request table.

Knapsack is a combinatorial algorithm that is used in the platform to find the lowest value for the forex requested. The algorithm does a total number of two to the power of (number of bids placed on the request) combination, to find the final value. When the lowest combination is found, the values are then displayed and updated in the request table in the database.

```
// combinatorial algorithm called Knapsack is used to find the lowest bid placed on the request.
// data from the bid table is split into different arrays, according to their category.
$bidder_name[$index] = $rows['fullname'];
$offer[$index] = $rows['forex_amount'];
$value_offer[$index]= $rows['bid'];

//get the combination for forex offered
function get_combination($offer,$variable,$cost,$costs,$combos,$name_combos)

for ($i=0; $i < count($offer); $i++)
    for ($j=0; $j < count($variable); $j++)
        if (pow(2,$j) & $i){
            $variable[$i][$j] = $offer[$i];
            $costs[$i][$j] = $value_offer[$i];
            $name_combos[$i][$j] = $bidder_name[$i];
        }

//get the total value for each combination
$sum = 0;
$total_cost = 0;
$minimum = 0;
for($i=0; $i < count($variable); $i++)
    for($j=0; $j < count($costs[$i]); $j++)
        if ($costs[$i][$j] > $minimum){
            $minimum = $costs[$i][$j];
        }
    $sum = $sum + $variable[$i][0];
    $total_cost += $costs[$i][0];

for($i=0; $i < count($costs[$i]); $i++)
    if ($costs[$i][$j] < $minimum){
        $sum = $sum + $variable[$i][0];
        $total_cost -= $costs[$i][0];
        $minimum = $costs[$i][0];
    }
```

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Figure 13: This is the representation of the Knapsack algorithm used in order to find the lowest bid placed. Once the lowest bid is found the new information is updated on the Trade table and contains the forex amount, value of the forex and the names of the bidders.

```php
//get the minimum bid placed
for($i = 0; $i<count($variable); $i++){
    for($t = 0; $t<count($variable); $t++){
        echo "$variable[$t][$i]" . $variable[$t][$i] . "n";
    }
    $offers = 0;
    $bidders = "";
    for($c=0;$c<count($combination); $c++){
        if($combination[$c] == $request){
            $minimum = $cost_array[$c];
            $offers = $variable[$c];
            $bidders = $name_combo[$c];
            for($z = 0;$z<count($cost_array); $z++){
                if(($combination[$z] == $request) && ($cost_array[$z] <=$minimum)){
                    $minimum = $cost_array[$z];
                    $offers = $variable[$z];
                    $bidders = $name_combo[$z];
                }
            }
        }
    }
    if($minimum != $row['bid_amount']) || ($row['bid_amount'] != 0){
        //update current bid if new bid has a lower cost
        if(count($bidders) > 1){
            $bidders = implode("", $bidders);
            $offers = join("", $offers);
            $sql = mysql_query("UPDATE Add_Trade SET bid_amount='$minimum', bidder_name='$bidders', forex_amount='$offers' where id='$form_name1',connects");
        }else{
            $bidders = implode("", $bidders);
            $offers = join("", $offers);
            $sql = mysql_query("UPDATE Add_Trade SET bid_amount='$minimum', bidder_name='$bidders', forex_amount='$offers' where id='$form_name1',connects");
        }
    }
}
```
12.2.5 Delete Request Or Bid

The following program simply allows users to delete their requests and bid, but it only deletes the data on the users side and a record is kept on the database all re moved bids and requests.

```php
include('session.php');

if(isset($_SESSION['login_user'])){
    echo " Note: Please <a href='signup.php'>Sign up</a> or <a href='login.php'>log in!</a> ";
} else{
    $deleting = $_POST['request'];
    if($deleting == "DeleteRequest") {
        $sperson = $_SESSION['login_user'];
        $form_name = $_POST['formname'];
        $connection = mysql_connect("localhost", "root", "");
        $db = mysql_select_db("Project", $connection);
        $result = mysql_query("UPDATE bid_and_trade SET deleted='DELETED' where id = $form_name AND fullname = 'sperson'";$connection);
        header('Location: MyRequests.php');
        if (!$result){
            die('Error: '.mysql_error());
        mysql_close($connection);
    }
}
```

Figure 14: This is a representation of the program that deletes selected requests by the user.

```php
include('session.php');

if(isset($_SESSION['login_user'])){
    echo " Note: Please <a href='signup.php'>Sign up</a> or <a href='login.php'>log in!</a> ";
} else{
    $deleting = $_POST['Bid'];
    if($deleting == "DeleteBid") {
        $sperson = $_SESSION['login_user'];
        $form_name = $_POST['formname'];
        $connection = mysql_connect("localhost", "root", "");
        $db = mysql_select_db("Project", $connection);
        $sql = mysql_query("UPDATE bids SET deleted='DELETED' where id = $form_name AND fullname = 'sperson'";$connection);
        header('Location: MyRequests.php');
        if (!$result){
            die('Error: '.mysql_error());
        mysql_close($connection);
    }
}
```

Figure 15: This is a representation of the program that deletes selected bids by the user.
12.2.6 Rates

Using the file get contents function in php, we are able to get the updated rates. Each time the rates page is refreshed and the user is connected to the internet, the current rates are then displayed on the interface.

```php
<?php

// This program is used to get the updated rates. The contents received from another web page is then split and replaced in order to be able to display the rates in a table form. Rates can only be updated if the user is connected to the internet.

echo "<h1>Rates</h1>";
$homepage = file_get_contents('http://www.x-rates.com/table/?from=AUD&amount=1'); // Get rates from x-rates.com
$string = array();
$spar = split('<span>', $homepage);
$string = $spar;

$splitt2 = split('<span class="rateTableAlpha">Alphabetical Order</span>', $string);
$new = str_replace('<table class="rateTable" cellspacing=0 cellpadding=0>', '<table border="1" style="width:300px;">', $splitt2[0]);

echo $new;
?>
```

Figure 16: This is a representation of the program used to get the updated rates.
12.2.7 Graph

The linear regression graph is used to represent the data in the database. Tags and labels are used to identify what each point and axis represents. Python is used to get the data from the database, calculate linear regression and display the graph.

```python
import MySQLdb
import sys
import numpy as np
import matplotlib.pyplot as plt

def linear_regression(x, y):
    x = np.array(x)
    y = np.array(y)
    labels = ['USD', 'EUR', 'GBP', 'AUD', 'CHF', 'INR', 'SGD', 'CAD', 'EUR', 'JPY']
    slope, intercept, r_value, p_value, std_err = stats.linregress(X, Y)
    # Calculate some additional outputs
    predict_y = intercept + slope * X
    resid_error = y - predict_y
    degrees_of_freedom = len(x) - 2
    residual_std_error = np.sqrt(np.sum(resid_error ** 2) / degrees_of_freedom)
    x = np.arange(10)
    plt.plot(X, Y, 'bo')
    plt.plot(X, predict_y, 'k-')
    plt.title('Currency requested')
    plt.xlabel('Currency requested')
    plt.ylabel('Currency')
    for label, x, y in zip(labels, x, y):
        plt.annotate(label, xy=(x, y), xytext=(-20, 20),
                     textcoords='offset points', ha='right',
                     bbox=dict(boxstyle='round,pad=0.5', fc='yellow', alpha=0.5),
                     arrowprops=dict(arrowstyle = '<->', connectionstyle = 'arc3,pad=0'))
    plt.savefig('representation.png')

connection = MySQLdb.connect("localhost", "root", ", "Project")
cursor = connection.cursor()
cursor.execute("SELECT currency, amount FROM Trade")
data = cursor.fetchall()
currency = []
amount = []
for row in data:
currency.append(row[0])
amount.append(row[1])
```

Figure 17 : This a representation of the program used to display the linear regression graph.
12.3 Back End System

The back end systems are responsible to take in inputs from users and run the processes required during the trading process. The back end uses forms and select options to take in the input from users. The input provided by the users is then stored in the database. A combinatorial algorithm named Knapsack is used to do the reverse auction method. Knapsack takes in the bids entered by the users and finds all the possible combinations between the bids placed for a specific request. Once all the combinations are done, the total value of the combinations is compared to that of the one being requested. When combinations that are equal to the forex requested are found the values of the forex requested are then compared as well. A minimum value of the to alt requested is selected as the lowest bid and displayed with the forex requested. The knapsack algorithm takes a minimum of 0.00148391 milliseconds to find the lowest possible combination for the forex amount requested. An increase in the amount of bids placed on the requested forex causes an increase in the time knapsack takes to find the lowest combination of bids.
13 Testing

The testing process is used to evaluate and update the forex trading system. In the next section we take a closer look at the functionality process, System testing process and testing results.

13.1 Functionality Testing

Testing is the process of evaluating the functionality requirements. To be able to classify a system as a high quality system, there has to be no known errors and all functional requirements have to be met. Keeping in mind the functional requirements mentioned previously, the testing process beings with first having to take a look at the registration process.

13.2 Unit Testing

Unit testing is the process of testing the functions individually. Two dummy accounts are created by using a sample email address which exists in order to test the functionalities.

13.2.1 Registration and Email Verification

Information such as the name, surname, email and password is entered on the registration page, once that is done the register button is selected to submit the information. After the button is selected an email containing the login link is sent to the entered email address and a new user profile is created. Once the email has been verified, boolean numbers are used to differentiate if the user can log in or not. Where a zero means false and ones mean true. When the email verification process is done, the system redirects the user to the home page.

13.2.2 Login

User can login using the email and password, which is first compared to email and password that is stored in the database. The user session is started if the details are correct.

13.2.3 Adding Request

A request is placed by selecting the Add trade button on the Trade page. The user is redirected to the add trade page where they are required to enter the currency from the list given and the amount requested. The requests placed is added to the database and displayed on the Trade page.

13.2.4 Bidding

Bidding on the request can only occur when the user is logged in and not bidding on their own request. The bidding process allows users not only bid on the total amount requested, but for any amount below the requested value. This is due to the fact that the lowest bid is selected using the combinatorial algorithm called Knapsack. The bid placed is entered into a Bids table in the database.
13.2.5 Delete Request or Bid
The delete function works for both requests and bids placed by the logged in user. The logged in user is able to delete the specific entry that they have placed. When that occurs the selection process of the lowest bid and displaying requests is redone. Entries are deleted by selecting the delete button. Deleted entries are marked in the database as deleted as they are required when creating the linear regression graph.

13.2.6 Transaction Verification
A time period selected by users is displayed to allow bidders to bid on the request. Once the request has expired, an email with the transaction details is sent to the users personal email address.

13.2.7 Logout
The user can then select the logout link to end their session.

13.3 Integration Testing
Integration testing is the process of testing the functionalities at the same time, to establish if there are no known errors and that all the functions work at the same time without crashing. This process is done by creating an account and using the information stored in the database, which was obtained from the two dummy accounts created to test the functions individually. The new account is then created to bid on the requests that were already placed, to place another request and check that a user can not bid on their own request.

A different approach to integration testing requires multiple user accounts created by different people. The multiple users asset in verifying that the main function of the platform works and does the calculations correctly. The purpose of creating more users was to test the ability of users to offer which ever amount they would like to offer. Based on the information entered for each offer the Knapsack algorithm was implemented in order to find the lowest combination of offers. Each request has a set time to bid on and once that time is reached the request is removed and necessary information is sent to the buyer.

13.4 Usability Testing
Usability testing is the process of testing the platform by having users perform the test. Usability testing is done in order to get the users perspective, this includes the process of checking for errors, how the users respond to the platform and whether the platform is user friendly or not.

13.5 Test Results
The test results are calculated using the usability testing survey, which was given to users who were asked to do an integration test on the platform. Each pie chart is a
representation of the results for each question on the survey. Below is a representation of the usability testing survey that was given to participating users after performing the integration testing on the platform.

### Usability Testing Survey

Thank you for taking the time to be part of the usability testing process. Would like to ask that you please complete this survey by simply marking your response with an (x).

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1. I purchase foreign currency often.
2. It saves me time when I use the website.
3. I don’t notice any inconsistencies as I use the website.
4. I can recover from mistakes quickly and easily.
5. I found the various functions in this system were well integrated.
6. I think I would like to use the website frequently.
7. I would imagine that most people would learn to use this website very quickly.
8. The website is easy to use.
9. I would recommend the website to a friend.
10. The website is fun to use.

Figure 19: The survey questions are structured in order to be able to know if whether or not the platform would be recommended to other users, if the platform is easy to understand and if the users were able to do tasks such as bid and request. A number of ten users were asked to take part in the testing process and the results were as follow.
Figure 20: The following representation is a pie chart displaying the results obtained for question one. The chart shows that seventy five percent of the users do not purchase forex often and only twenty five percent of them actually purchase often.

Figure 21: This is a representation of the results obtained in question two. The chart shows that seventy five percent of the users say that the platform may maybe save them time when using it, while twenty five percent agree that it would save them time.
Figure 22: This is a representation of the results obtained in question three. The chart shows that fifty percent of the users agree that they have not noticed any inconsistencies when using the platform, while twenty five percent have noticed inconsistencies and others suggest that they might have.

Figure 23: This is a representation of the results obtained in question four. The chart shows that seventy five percent of the users agree that they can recover from mistakes made on the platform quickly, while twenty five percent are unsure.
Figure 24: This is a representation of the results obtained in question five. The chart shows that twenty five percent of the users find that the functions were well integrated, while fifty percent are unsure and twenty five percent strongly agree.

Figure 25: This is a representation of the results obtained in question six. The chart shows that fifty percent of the users would use the website frequently, while twenty five percent disagree and the rest are simply unsure.
Figure 26: This is a representation of the results obtained in question seven. The chart shows that all users agree that other users would learn how to use the platform very quickly.

Figure 27: This is a representation of the results obtained in question eight. The chart shows seventy five percent of the users find the platform to be easy to use and twenty percent do not find it easy to use.
Figure 28: This is a representation of the results obtained in question nine. The chart shows that more than twenty five percent of the users would recommend the platform, while a fifty percent of them were unsure that they would.

Figure 29: This is a representation of the results obtained in question ten. The chart shows that only twenty five percent of the users found the platform to be difficult to use and twenty five percent agree and strongly agreed.
14 Conclusion

Through the testing phase we have proven that users can recover easily from mistakes that they have made. All the functions are integrated together with minimal errors. However we have been unable to upload the interface on the server due to a number of restrictions. Uploading the interface on the server would simply mean that the email verification and notification would not occur. This is due to the fact that the server blocks all out going mails to unknown addresses. An eligible way to get the system working, while running the knapsack algorithm and the database is required in order to avail the interface to all users.
## 15 Project Plan

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References


